DOCUMENT RESUME

ED 265 042 SE 046 343

TITLE	Estuaries and Tidal Marshes. Habitat Pac.
INSTITUTION	Fish and Wildlife Service (Dept. of Interior), Washington, D.C.; National Inst. for Urban Wildlife, Columbia, MD.
SPONS AGENCY	EXXON Corp., New York, N.Y.
PUB DATE	Sep 85
NOTE	38p.; For related documents, see ED 251 306-307, and SE 046 342.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Animals; *Ecology; *Environmental Education; *Estuaries; Intermediate Grades; Junior High Schools; *Learning Activities; *Outdoor Activities; Science Activities; Science Education; *Wildlife
IDENTIFIERS	*Marshes

ABSTRACT

This educational packet consists of an overview, three lesson plans, student data sheets, and a poster. The overview examines estuaries and tidal or salt marshes by discussing the plants and animals in these habitats, marsh productivity, benefits and management of the habitats, historical aspects, and development and pollution. A glossary and list of reference materials are included. The lesson plans provide a statement of purpose, a list of learning outcomes, instructional strategies (including those related to student data sheets), a list of materials needed, and a quiz. The lessons focus on: (1) the influence of tides on the habitats; (2) productivity and recreational values of tidal marshes and estuaries; and (3) how estuaries function as "nutrient traps." The two-sided poster shows (on side 1) the plants and animals that live in the various zones of a salt marsh and (on side 2) a gallery of estuarine species and products that are important to commercial and sport fishing in the United States. An additional student sheet is also included with a "hidden animal puzzle" on one side and a poem which depicts the salt marsh experience on the other side. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

Estuaries and Tidal Marshes

Habitat Pac

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ED265042

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
U.S. Fish and Wildlife
U.S. Dept. of Interior
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

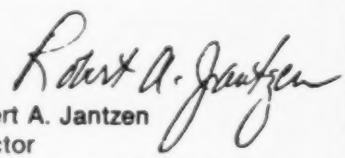
SE046343

A Message To Educators

As teachers and educators, you undoubtedly hold a firm belief in the importance and promise of education. As Director of the U.S. Fish and Wildlife Service, I find daily evidence that causes me to share this belief.

In the Fish and Wildlife Service we manage millions of acres of land, conduct wildlife research, raise fish for restocking depleted waters, and perform hundreds of other tasks designed to benefit fish and wildlife resources. However, as important as these activities are, I am convinced that in the long run an informed, motivated, and involved public can do more to benefit wildlife than all of the Service's management efforts.

This education package represents a first step in our increased emphasis on the use of education to enhance wildlife resources. I hope you find the material it contains useful and enjoyable.



Robert A. Jantzen
Director
U.S. Fish and Wildlife Service

Contents

Habitat Overview
The Overview presents estuaries and tidal or salt marshes as unique habitats occurring in many coastal areas where freshwater and saltwater mix. These productive habitats are vital to many fish and wildlife species and are in danger of destruction through development, pollution, and other human threats.

Poster: Side 1
This poster illustrates the plants and animals that live in the various zones of the salt marsh. It also demonstrates how plants and animals have adapted to water level changes and salinity. Use this poster to reinforce Lesson Plan 1.

Poster: Side 2
A gallery of estuarine species and products that are important to commercial and sport fishing in the United States. Use this side to introduce the habitats and to establish strong links between estuaries and human dependence on them.

Student Page 1: Hidden Animal Puzzle
Many creatures blend in with the surroundings of the tidal marsh. The student will have to search for some of them in a hidden puzzle picturing a typical estuary scene.

Student Page 2: Marsh Tide
A poem, depicting the salt marsh experience, will guide the readers to their own expressions and feelings about their field trip encounters.

Lesson Plan 1: Tides and Zones
This lesson helps students to become acquainted with the important tidal influence on these habitats. On a field trip, the class will measure the rate of an outgoing tide and examine the distinct zones of plant and animal populations.

Lesson Plan 2: Necessary Estuaries
Taking a field trip, the class visits a fish cannery, marina, or other marine industry that is dependent on the creatures living in the estuary. Students will find out firsthand about the productivity of estuarine and salt marsh habitats.

Lesson Plan 3: Marsh Math
Where saltwater and freshwater meet, nutrient-trap action results in abundant productivity; this same action traps pollution which can destroy estuarine organisms or poison them. These concepts are worked out in math examples.

Coastal Salt Marsh Habitats of the United States

Estuaries and Tidal Marshes

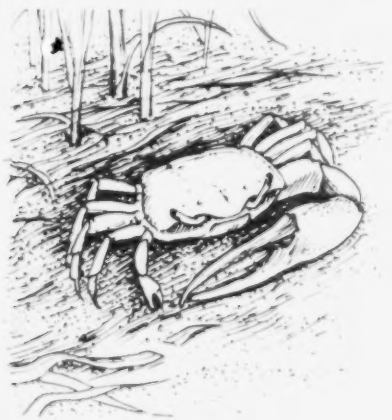
Habitat Overview

"Along the . . . coast of North America . . . tenaciously holding the land together with a tangle of roots, lies a green ribbon of soft, salty, wet, low-lying land, the salt marshes.

"The ribbon of green marshes, part solid land, part mobile water, has a definite but elusive border, now hidden, now exposed as the tides . . . fluctuate."

—John and Mildred Teal
Life and Death of a Salt Marsh

This passage captures the essence of the **tidal salt marshes:** Habitats of the ocean-land interface, ruled by tides.



Fiddler Crab

Adapting to the Tides

Tide changes are a dominant feature of life in the tidal marsh and estuary. Marsh plants and animals must adapt to the rigors of constant change. Temperature, salinity, moisture, and available oxygen fluctuate as the marsh is constantly flooded and drained. Cordgrass and some ducks have special glands for eliminating excess salt. During low tide, fiddler crabs and clams burrow into sand and mud for shelter. Barnacles close their shells tightly to keep from drying out.

Marsh wildlife lives in **tidal zones** characterized by fluctuating water levels. Higher ground, inundated less frequently and for shorter periods, is inhabited by organisms with lower tolerance of salt and water. Such species as tall cordgrass and eelgrass grow near the sea, while salt marsh hay and black grass (black **rush**) grow on higher ground. In the lower, wetter parts of the marsh, the animal species include clams, mussels, and lugworms; the high or drier areas support various crabs and snails.

Glasswort (pickleweed)

Salt marshes and estuaries are closely related coastal brackish water ecosystems. Estuaries are places such as bays and river mouths where saltwater mixes with freshwater from rivers and creeks. Salt marshes form in shallow, protected tidal flats, often adjacent to estuaries.

Tall Cordgrass

The salt marshes of the North American coasts are the most extensive in the world. These ecosystems occur extensively on the broad, gently sloping continental shelf of the Atlantic and Gulf Coasts. On the steeper Pacific Coast, salt marshes are less common but still plentiful.

Marsh Productivity

Salt marshes and estuaries are among the world's most productive ecosystems. Marsh productivity begins as the sun's energy is captured by marsh plants. Cordgrasses, algae, and **microinvertebrates** thrive in the shallow, nutrient-rich water. Salt marshes produce more plant material per hectare (2.47 acres) than the best wheat fields.

Marsh Animals

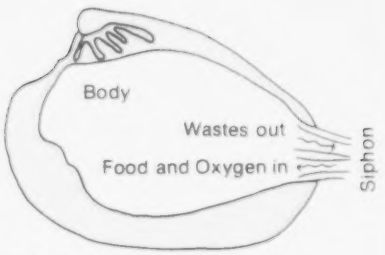
Marsh plants support abundant animal life. Only a few animals feed directly on living cordgrass. More often, the organic material in these plants is consumed after the plants die and are broken down into **detritus**. Fiddler crabs, snails, insect larvae, bacteria, clams, and even some small fish (mullet, menhaden) feed directly on detritus. Tides carry some of the rich detritus from marshes into adjacent estuaries where productive bottom-dwelling communities (oysters, clams, mud worms), plankton, and fish abound.

Many birds and mammals find food and shelter in the salt marsh. Raccoons and otters come in search of crabs and mussels; muskrat feed on cordgrass. Marshes provide feeding and resting stops for migrating and wintering birds. Rails, marsh wrens, and other birds nest in marshes where they eat insects, snails, crabs and small fish.

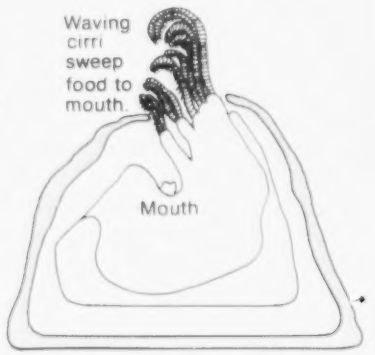
Estuaries and salt marshes provide temporary habitats for many creatures that live out most of their lives elsewhere. They function as nurseries for marine animals that inhabit offshore areas as adults. Young shrimp, menhaden, and flounder grow in estuaries. Adult salmon and striped bass may rest and acclimate there on the way to upstream spawning grounds, as may juveniles on the way to the ocean. When the marsh is covered with water at high tide, fish and shrimp swim in looking for food. The movement of tides transports eggs, larvae and young animals, which cannot swim on their own, from bays to salt marshes.

Two special conditions augment the high productivity of salt marshes and estuaries — the "energy subsidy" of the tides, and their ability to trap nutrients. Some animal species, instead of foraging for their food, are fed by the tides. **Filter-feeders**, such as clams, siphon food from the water as every tide brings a rich supply. Marsh and estuarine organisms expend less energy to "work" finding food and thus have more energy available for growth and reproduction.

Filter-feeders

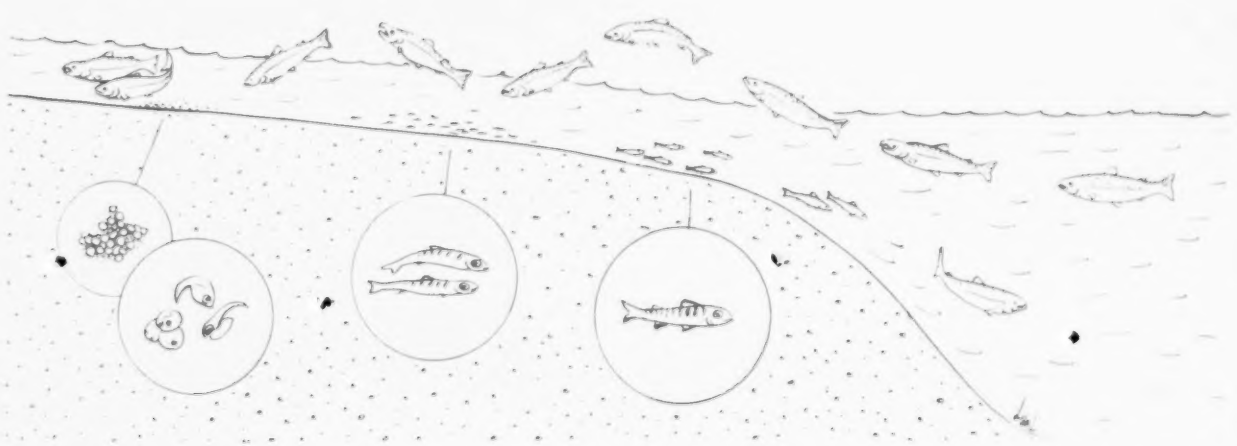


Soft-shell Clam

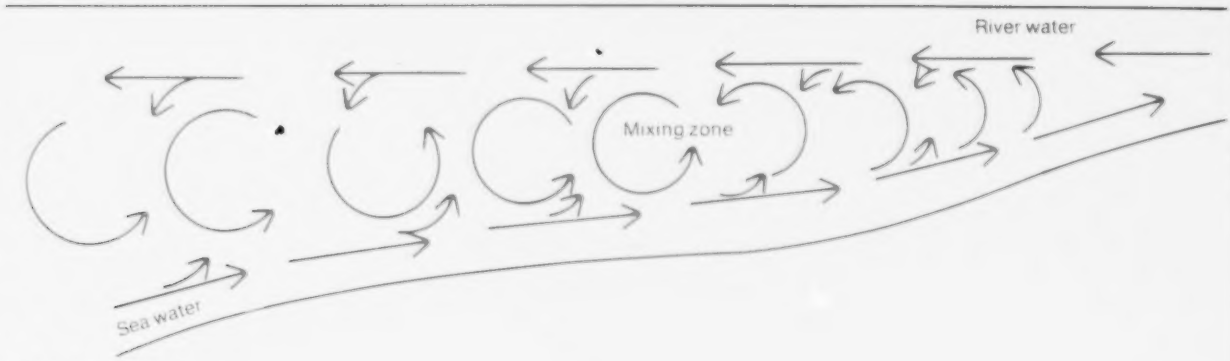


Barnacle

A nutrient trap holds and accumulates nutrients carried in from rivers to the estuary. Since freshwater is lighter than saltwater, the freshwater forms a layer on top of a "salt wedge" of ocean water. As the freshwater layer mixes with the higher salinity estuarine waters, nutrients flow back and forth with the tide and are recirculated. This supplies abundant food to marsh and estuarine organisms.



Life Cycle of the Coho Salmon



Nutrient Trap

Bounty and Beauty

Many people are unaware of the productive benefits of salt marshes and estuaries. Unlike wheat fields, these ecosystems grow plants which are not directly consumed by people. However, humans do reap a harvest here of fish, shrimp, and crabs. More than half of the species important to fisheries in the coastal United States depend on estuaries. The loss of these fisheries would have serious effects on the economy and diet of many people.

Salt marshes and estuaries are valuable for the beauty and recreation they provide for people. Their open space is a refreshing contrast to increasing urbanization. Hikers and bird watchers flock to these areas; hunters visit the marsh for waterfowl and other birds; sport fishermen, clammers, and crabbers find plentiful catches.

Historical Perspective: An Age-Old Resource

Since ancient times, many Native Americans, attracted by opportunities to hunt and fish, built villages near salt marshes and estuaries. During spawning seasons, fish were so plentiful that people could scoop them out of the water in baskets. Native Americans also built fish traps in tidal creeks and dried their catch for winter food.

Early settlers also hunted and fished in marshes. They harvested marsh hay for their cattle. Such activities left the marsh relatively unchanged. Soon, however, people built harbors in estuaries and **dredged** and straightened marsh creeks so that boats could reach settlements. Garbage from towns was dumped on the open spaces of the marsh. Humans started to change an environment they would only begin to understand centuries later.

Development and Pollution

The delicate salt marsh and estuarine systems are particularly vulnerable to a variety of human abuses. The two major threats are pollution and physical destruction.

The estuaries' ability to trap nutrients means they can also accumulate wastes dumped into rivers that feed them. Salt marshes also receive garbage dumped offshore and carried in by tides. Toxic chemicals in these wastes may become concentrated in plants and animals, killing them or leaving them unfit for human use. Nutrient-rich wastes, containing phosphates and nitrates from detergents, sewage, or agriculture may overstimulate plant growth. Decomposition of dead plants and wastes uses up oxygen. This decomposition can remove so much oxygen from the water that many organisms cannot survive. Oil contamination from many sources — motorboats, leaks, spills — threatens aquatic animals and birds. Thermal pollution may occur when water that has been warmed when used for industrial cooling is discharged into a marsh or estuary. The warmer temperatures can kill animals outright, or alter their life cycles.

Estuaries and salt marshes are being destroyed for various reasons. Marshes are often used as garbage dumps; they are also drained to control mosquitos or filled to make sites for homes, factories, and roads. Estuaries and marsh creeks are dredged to deepen them for navigation. This can smother fish and oysters as silt clogs their gills. Spoils from dredging operations are often dumped on marshes, burying plants and animals.

Indian Clam Shell Midden

Management

Increasing human demand for land, electric power, and ship transportation can influence salt marshes and estuaries. Considering the natural functions of these systems, their preservation is an important matter. Different sites can be chosen for garbage dumps. Marshes don't have to be filled, drained, or sprayed for mosquito control; maintaining water levels so that certain small fish can reach and devour the mosquito larvae is one control method. Factories and homes built on filled land are better located elsewhere — where storms cannot wash them away.

Salt marshes and estuaries cannot be managed for both development and natural values. With increasing awareness of the importance of salt marshes and estuaries, Federal, State, and local governments are taking steps to protect them. Some areas have been purchased for preserves, and laws help to control development in others.

Besides preserving salt marshes, people manage them to increase their benefits. Fishing and hunting regulations are designed to prevent depletion of wildlife, assuring a continued harvest. Oyster production has been increased by the use of intensive culture methods.

"... Compromises on conflicting uses [of salt marshes and estuaries] must be made in terms of the welfare of the whole. Since 'everybody' (man and organisms) lives downstream from everybody else in an estuary, modification or pollution at one point affects distant points in both tidal directions and even in adjacent oceans. Accordingly, the entire estuarine ecosystem must be studied, monitored, managed, and zoned and human uses regulated in terms of the whole."

— E.P. Odum
*Fundamentals of Ecology**

*W.B. Saunders Co., Philadelphia, 1971

Glossary

detritus — Tiny particles of decaying plant and animal matter.
dredge — To deepen a waterway by digging up the bottom.
estuary — An area where freshwater and saltwater mix, e.g., bays and river mouths.
filter-feeder — An animal that feeds by filtering plankton or detritus from the water, with tentacles, gill rakers, or other sievelike organs.
microinvertebrates — Microscopic plants and animals (plankton) that float or weakly swim in a body of water.
rushes — Grasslike plants that grow in wet areas; this common name is applied to many kinds of plants.
salt marsh — A tidal wetland that is covered at least periodically with saltwater and is dominated by nonwoody vegetation such as cordgrass.
tidal zones — The area between high and low tide. In the intertidal zone there often are distinct divisions of plants and animals in the salt marsh — caused by the different water depths and duration of the tides in different parts of the marsh.

Resources

General References

Between Pacific Tides, Edward F. Ricketts and Jack Calvin. Stanford University Press, Stanford, California, 1968.

"Can We Save Our Salt Marshes?", Stephen W. Hitchcock. *National Geographic*, National Geographic Society, Washington, D.C., June, 1972, pages 729-765.

Life and Death of a Salt Marsh, John and Mildred Teal. Little, Brown and Co., Boston, 1969.

Life In and Around the Salt Marshes, Michael J. Ursin. Thomas Y. Crowell, Co., New York, 1972.

The Life of the Marsh, William Niering. McGraw-Hill Co., New York, 1966.

The Sea Around Us, Rachel Carson, Oxford University Press, New York, 1961.

The Seashore World, David F. Costello. Thomas Y. Crowell, New York, 1980.

For Young Readers

Along the Seashore, Margaret S. Buck. Abingdon Press, New York, 1964.

Estuaries, Laurence Pringle. MacMillan, New York, 1974.

Field Book of Seashore Life, Roy Waldo Miner, G.P. Putman's Sons, New York, 1950.

Questions and Answers About Seashore Life, Ilka K. List. Scholastic Book Services, New York, 1970.

Plankton: Drifting Life of the Waters, Julian May. Holiday House, New York, 1972.

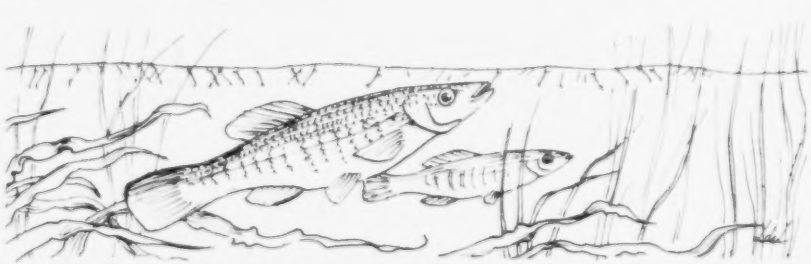
Films and Filmstrips

Men at Bay. King Screen Productions, BFA Educational Media, Santa Monica, California, 1972.

World in a Marsh. National Film Board of Canada, N.Y., 1958.

The Salt Marsh. National Geographic Film Strip, Washington, D.C., 1972.

The Salt Marsh. A Question of Values. Encyclopedia Britannica, Chicago, 1975.

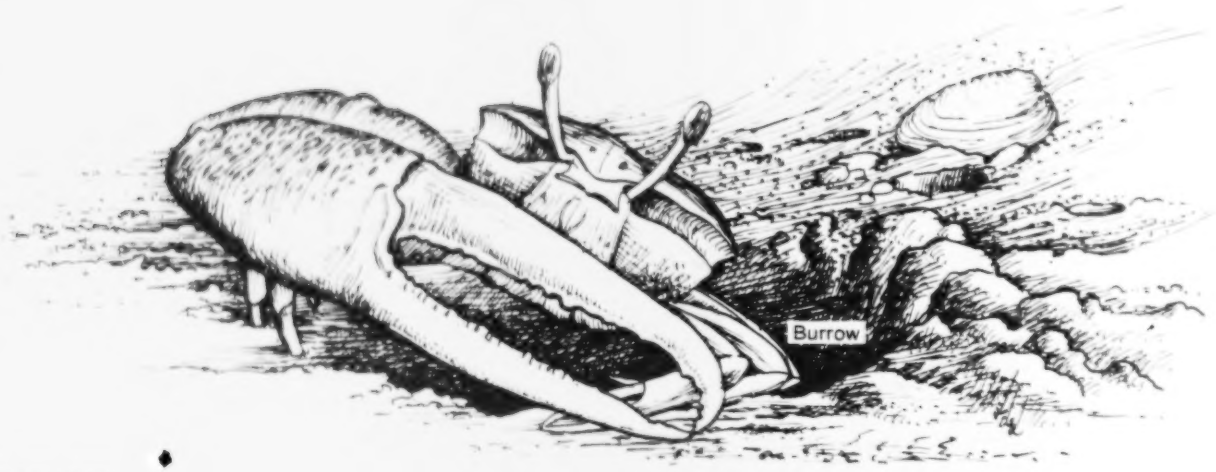


Killifish Eating Mosquito Larvae

Estuaries and Tidal Marshes

Lesson Plan 1

Tides and Zones



Fiddler Crab

Purpose

In this activity students investigate the movement of tides, tidal influence in a salt marsh, and the kinds of marsh life found in different tide zones.

Learning Outcomes

After completing this activity, students will be able to:

A. Explain how tides are an important factor influencing life in a salt marsh.

B. Describe in writing two ways in which tidal marsh organisms adapt to the changes in salinity and water levels.

C. Predict the time of the tides in a coastal area, using a tidetable.

D. List two common plants and animals found in the marsh they have studied.

Organization

Who: Students in pairs
Where: Tidal marsh
When: 2 or 3 hours before low tide
Time: 1 to 2 hours
Safety: This lesson should be conducted during an outgoing tide. Students should be organized into buddy teams, and, if they enter the water, should not go further than ankle deep. Arrange for adequate supervision near the water (at least one adult per 10 students); warn students about the dangers of drop-offs and possible problems with soft mud bottoms.

Materials: For the Group

- Field guide for salt marsh organisms (optional — see Resources)
- Insect repellent
- Tidetable — available in local newspapers or sporting goods stores
- Magnifying lens
- Shovel

Materials: For Each Student

- Data sheets and pencil
- Clipboard (Masonite or stiff cardboard with a paper clip or binder clip)
- Boots or old shoes; old clothes (students will get muddy)

Directions

1. Select from the tidetable a date and time for the activity so that you can arrive at the salt marsh 2 to 3 hours before low tide.

2. In the classroom discuss what causes tides. Duplicate the tidetable or display it on the chalkboard. Discuss with the class how to read a tidetable and how they might observe the patterns of tide changes.

3. At the tidal marsh, distribute the above materials to students. They should wear their boots or mud shoes for going into the marsh.

4. Form the class into buddy teams and tell them that buddies are responsible for each other's safety. (The students should walk carefully in the marsh to avoid falling. They should be shown how to feel ahead with the leading foot to find drop-offs or soft spots.)

5. Challenge the students to prove which way the tide is moving. (It should be moving out.) They may select a reference point, such as a rock or piling, and note the changing water level. Is your tidetable accurate? (You might want to begin the first part of the sampling exercise while waiting for the water level to change. While sampling, look for any other evidences of tidal change, such as high water marks on pilings.)

6. Tides are constantly going up and down. Sometimes the marsh is wet, sometimes dry. The low parts are wet for longer periods than the high parts. Can the students think of any ways in which these tidal changes would affect plants and animals in the marsh? Examples of adaptations to marsh living: maintaining a salt balance (special glands in cordgrass and some ducks); avoiding drowning or drying out as the tide changes (insects climb out of the water on vegetation; clams close up tightly; fiddler crabs have both gills and a primitive lung); avoiding predators that come in with the tide (worms and sand fleas burrow into the mud), filter-feeding (clams, barnacles, mussels, and others filter food brought to them by the tides).

7. Tell the students they are going to investigate the kinds of plants and animals that live in different sections of the marsh. Move to the seaward edge of the marsh where the emerging marsh vegetation (cordgrass, glasswort) begins. This is the low-tide zone. Spread the students out along the edge so they can look for plants, animals (including insects and fish), and signs of animals. They should record these on their data sheets by drawing or describing them. Allow enough time to look carefully. As they record the organisms, students should make note of whatever special adaptations they notice.

Examine the substrate (soil). Is there much detritus here? (Tell the students what detritus is and that it serves as food for many animals. See Glossary.)

Repeat this sampling procedure for other zones described below. Note: Samples should be treated carefully and returned to the area in which they were collected. The exact widths of tidal zones and the species found in them vary among

Tall Cordgrass

Salt Grass

marshes. Zones can usually be delineated visually. Look for changes in height, texture, and color of the plants. (See also Poster, Side 1.) Try to pick out three zones (low-, mid-, and high-tide zones). Some marshes will have only two. Other variations in marsh vegetation occur along marsh creeks where water is always present and in pannes (shallow depressions where evaporation of the seawater left after the tide causes increased salinity).

8. When the students have finished their sampling, discuss the effect of tides on the marsh organisms. Are all areas going to be covered for the same length of time each day? (No — the low marsh is covered longer.) Were the same kinds of organisms found in all parts of the marsh? How might the tides affect the location of organisms? (They must tolerate more exposure to air in high zones.) Do birds and mammals move with the tides? What kinds of waterfowl and other wildlife might be in the areas at different times of the day or year? (For example, raccoons come to the marsh when the tide is out; fish come when the tide is in. Migratory birds would be more abundant in spring and fall.)

Followup

Humans can harm saltwater marshes without draining or filling them or dumping wastes on them. Considering the adaptations of marsh life to the tides, what happens when people build roads or dikes across the marsh that block the tidal flow? (Salt marsh plants and animals usually don't survive.) What is happening to marshes located in the student's own area?

Black Rush

Quiz Answers

1. Tidal patterns vary around the coasts of North America. Students should answer this question based on what they have learned about the tidal cycle in their own region.
2. Possible answers:
   a. To keep from drying out.
   b. To avoid predators.
3. Answers will vary according to the specific animals students found in the marsh.
4. Again, answers will vary. They should pertain to the problems of animals feeding, drying out, or escaping predators that are related to the changing tides.
5. False. Many marsh plants and animals need to be exposed to air some of the time and would die if continuously inundated. One of the principles of marsh zonation is different tolerances to exposure to air and water.

Name:

1. If high tide in your area is at 9:00 A.M., low tide will be at about _____ M.

2. What are two reasons animals in the marsh might close up (or burrow into the mud) when the tide is out?

a. _____

b. _____

3. Describe or draw one animal you found on the plants or on the ground in the high-tide zone, and one animal found in the low-tide zone.

High

Low

4. Name one way in which the two animals in Question 3 are different. Choose a difference that is related to the effects of the tides.

_____

_____

5. Read this statement. Is it true or false?
The same kinds of plants and animals would live in the salt marsh even without tides as long as there was water present. (Circle your answer.)

True **False**

Explain:

_____

_____

_____

_____

_____

Development in a Salt Marsh

Name:

Draw a map of the salt marsh showing the tidal zones you sampled.
Show plants, soil, animals and water.
Which zone is covered with water most times?

	Name of Zone:	Name of Zone:	Name of Zone:
Plants			
Animals or Animal Signs (Include Insects)			
Soil			

Name:

Estuaries and Tidal Marshes

Purpose

In this activity students examine the productivity and recreational values of the tidal marsh and estuary. The classroom lesson on the values of these ecosystems is followed by a field trip to a seafood cannery, fishing wharf, or sportfishing marina.

Mussel

Surf Fishing for Striped Bass.

Learning Outcomes

After completing this activity, students will be able to:

A. List two ways in which tidal marshes and estuaries are important to wildlife.

B. Name two ways in which tidal marshes and estuaries are important to people.

C. Name two ways in which people can alter or harm the tidal marsh/estuary ecosystems.

D. By choosing a statement from a list, express their concern that resources of the tidal marsh and estuary should be used carefully.

Organization

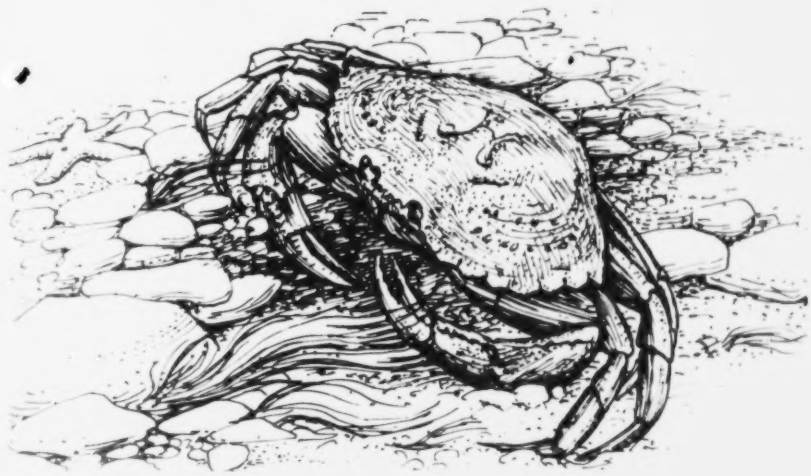
Who: Whole class
Where: Classroom and cannery, wharf, or marina
When: Spring, summer, or fall
Time: A 1-hour lesson and a 2-hour field trip
Safety: This field trip may take students into the proximity of deep water or tidal flow. Use the buddy system and include additional adult supervision (one adult for every 10 students).

Materials: For Each Student

- Pen
- Data Sheets
- Clipboard (Masonite or stiff cardboard with paperclip or binder clip)

Directions

1. Based on the information in the Overview and Resources, prepare a classroom lesson to provide background for the students' field trip. Direct them to information on the sea as a source of food, other products, and recreation. Estuaries and salt marshes provide thousands of hours of enjoyable recreation each year, while also providing nursery or feeding grounds for the majority of commercial species — fish, shrimp, oysters, etc. Use the Poster (Side 2) to illustrate this lesson. Refer also to the abundance and variety of plants and animals encountered during Lesson Plan 1.



Dungeness Crab

2. Arrange for the class to take a tour of a commercial operation that depends on the resources of the marsh or estuary, e.g., a cannery, fishing wharf, or sportfishing marina. Let the company know in advance what kind of information your class is seeking. The tour guide can then be prepared to answer questions.

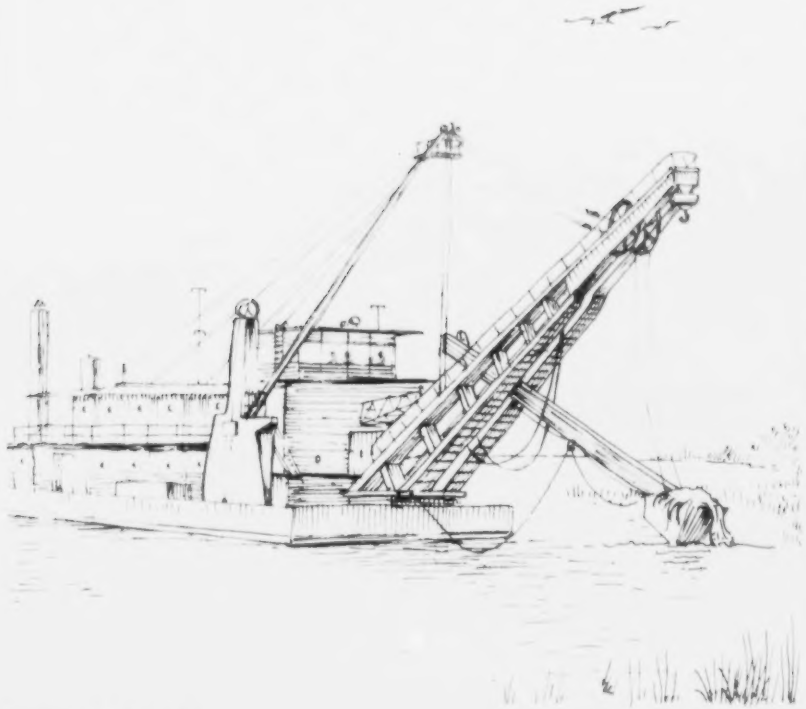
3. Before the tour, discuss the Data Sheet for the students to use in collecting information. Questions from the Data Sheet should elicit information on the importance of natural salt marsh and estuary resources for people. The questions should also address the effects that human activities have had on these resources. Students should fill out their Data Sheets based on observations and responses to questions they ask. Assign several students to ask particular questions and one or two others to record the answers. (The entire group should fill out their Data Sheets to be reviewed in class later.)

Try to tailor additional questions to the specific locality or operation you are visiting. More questions may arise during the tour, and students should be encouraged to ask them.

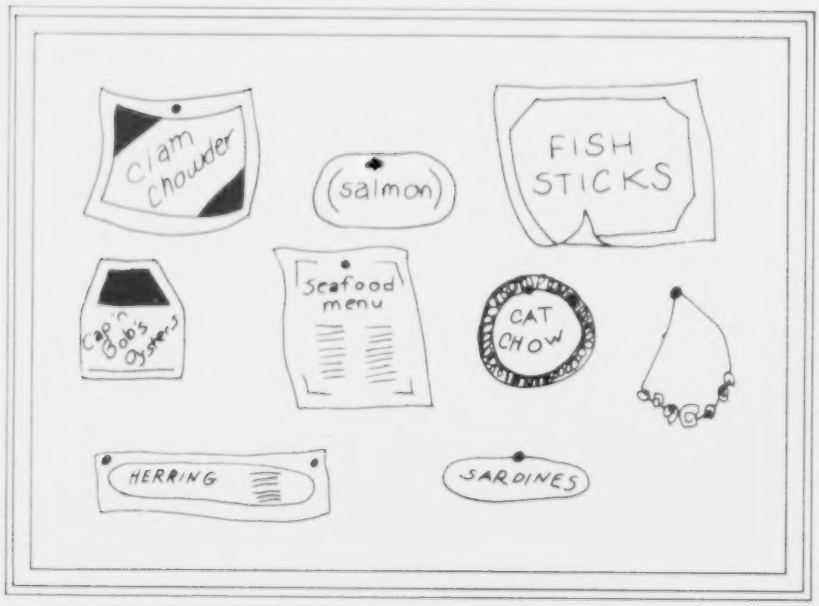
4. After the tour, help the class to summarize the importance of salt marsh and estuarine productivity, centering on the answers and information received. Call on the students assigned to record answers to questions for a summary of the information.

Be sure to stress the following point if it was not made by the tour guide: Many fish that are caught in offshore areas depend on estuaries in certain stages of their lives. Without the estuaries, these important fish would not survive. Consider also, what changes people's activities are causing in the estuary. (Filling, building, dredging, polluting — you may be able to point to examples nearby.) How will these changes affect the natural productivity of these ecosystems?

5. Note: If a field trip cannot be arranged, resource persons such as the manager of a cannery, the president of a sportfishing club, captain of a fishing boat, etc., might be invited to the class and be interviewed by the students.



Dredging the Estuary



Followup

Are estuaries and salt marshes important to the students themselves? As a followup to the field trip, let the class set up a bulletin board display of labels, advertisements, and pictures of products from the sea. These could be food labels, seafood restaurant menus, shell jewelry, or driftwood ornaments. This display will reinforce the importance of estuaries in students' lives.

The display can also be used to demonstrate a food web if items are linked together with yarn. In this case, it is important to include the human element—perhaps by including pictures of sport fishing, clam bakes, or several other human uses or consumptive activities.

Quiz Answers

1. In light of the seafood production emphasis of this lesson, the students will probably answer that there would be less fish to eat. Answers reflecting loss of seafood or wildlife production, or loss of recreation and esthetic value are acceptable.

2. This question asks an opinion and therefore should not be graded. After this lesson, however, students should recognize that undeveloped estuaries and marshes **c.** are important.

3. The animals' eggs hatch or young grow in the estuary; when they are older, they travel out to sea.

4. Dredging estuaries destroys the important bottom animal and plant communities and stirs up sediment in the water. The sediment in the water can clog fish gills and smother eggs, larvae, and bottom-dwelling organisms.

5. True. Tidal marshes are among the most productive ecosystems on earth.

6. False. People's actions (dredging, polluting, etc.) can drastically harm these ecosystems.

Estuaries and Tidal Marshes

Lesson Plan 2

Quiz

Name:

1. State two ways in which people's lives will change if many of the salt marshes on your coast are filled in and destroyed.

a. _____

_____

_____

b. _____

_____

_____

2. Circle the letter before the statement you agree with most.

a. Estuaries and tidal marshes don't take up a large portion of this country, so they probably aren't important to people.

b. Estuaries and tidal marshes are only important to people when used for buildings, harbors, or other developments.

c. Undeveloped estuaries and tidal marshes have values such as fish production that are important to people.

3. Complete the sentence:

Estuaries and tidal marshes are important as "nurseries" for many sea animals. The term nurseries means that

_____

_____

_____

4. Circle the human activity which can harm or permanently change the marsh or estuary.

- Swimming
- Digging the estuary deeper for big ships
- Catching fish within catch limits
- Canoeing on marsh creeks

Write **T** for **True** or **F** for **False** in the box by each statement below:

5. ☐ Tidal marshes are very productive places that support many animals and plants.

6. ☐ Tidal marshes and estuaries are natural ecosystems. People's actions do not affect them.

Name:

1. What is the history of the marsh/estuary area?

2. What is the history of this industry?

3. What is the status of the industry today?

4. What is the importance of this industry?

5. How does this industry depend on the resources of the salt marsh and estuary?

6. Have these resources been changing? How? Why?

Name:

7. What are the future prospects of the industry?
How are they linked to the marsh or estuary?

8. How are these resources helped, protected, or managed?

9. Are there regulations to help protect the resource?

10. How many pounds are caught per day? (Ask if applicable.)

11. How many people does the industry employ?

12.

Estuaries and Tidal Marshes

Lesson Plan 3

Marsh Math

Purpose

In this activity students will learn how estuaries function as "nutrient traps." This buildup of nutrients makes estuaries very productive environments. But the same function also renders estuaries vulnerable to the buildup of pollutants. Students will examine how the nutrients of a salt marsh or estuary are conveyed through a food chain.

Learning Outcomes

After completing this activity, the students will be able to:

A. State how tides cause an estuary to become a nutrient trap.

B. State how pollution can be accumulated in estuaries and in food chains.

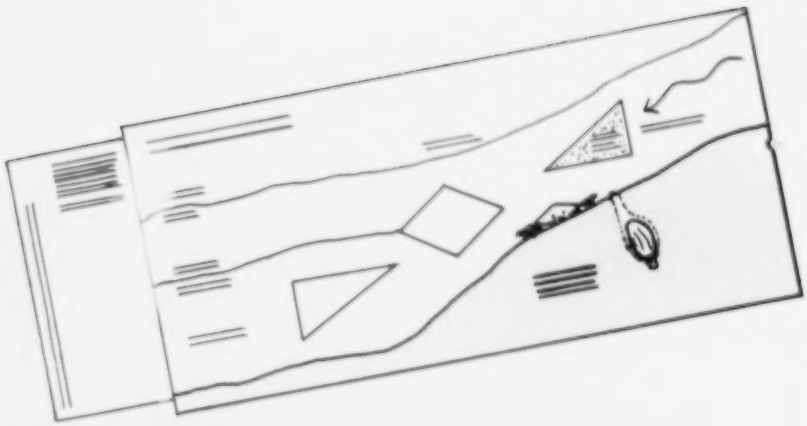
C. Solve simple mathematical problems dealing with the number of organisms in a food chain.

Organization

Who: Students working in pairs
Where: Classroom
Time: 2 to 3 hours

Materials: For Each Student

- Student Data Sheets
- Pencil
- Scissors
- Tape



Nutrient Trap Model

Directions

Nutrient Trap

1. The students will make a "working model" of an estuarine nutrient trap. Let them cut out and assemble the components of the model according to the directions printed on the Data Sheet, pages 1 and 2.

2. Discuss the importance of the nutrient trap to the wildlife living in a salt marsh and estuary. (See Overview.) What happens after nutrients, plankton, and detritus carried in from upstream and surrounding areas mix with the saltwater in the estuary? (The tide carries this food back into the estuary forming a "nutrient trap.") How does this affect the animals and plants in the estuary? (It provides more food.) Explain how the estuarine productivity is utilized by people. (See Poster, Side 2.)

3. Discuss what happens when people dump wastes upstream and in surrounding areas? (Pollution accumulates in the estuary; productivity may be drastically decreased.)

Marsh Math

The nutrient trap action occurring in salt marshes and estuaries makes them very productive habitats. To give the students a feeling for this productivity, some math exercises are provided. These illustrate the principle that many organisms at the bottom of the food chain are needed to support a few organisms at the top of the chain. (The data used in the exercises were simplified to demonstrate the productivity principle and do not represent actual numbers found in the marsh or estuary. The numbers are, however, reasonably close to what occurs in real life.)

4. Describe a hypothetical marsh, or let the students supply their impressions.

5. Tell the class that four living things are part of a food web in the above marsh, forming a food chain (marsh hawk eating seaside sparrow, eating grasshopper, eating cordgrass). What is on top of the food chain? (Hawk.) What plant or animal is on the bottom? (Cordgrass.)

Marsh Food Chain

6. Tell the class the following data were discovered by a wildlife biologist. Write the data on the chalkboard.

- Each hawk weighs 600 grams and eats 600 grams of sparrow each week.
- Each sparrow weighs 20 grams and eats 50 grams of grasshoppers each week.
- Each grasshopper weighs 1 gram and eats 15 grams of cordgrass each week.
- Each cordgrass plant weighs 5 grams.

7. Give each student page 3 of the Data Sheet to solve a series of marsh math puzzles using the data you have listed on the board. Encourge the students to help each other solve the problems. For more advanced students, the teacher may change the numbers to make the problems more difficult; for example, tell the students (and change the Data Sheet) that each hawk eats 612½ grams of sparrows. (This will allow students to work with fractions or decimals. See examples.)

8. There are usually more organisms on the bottom of the food chain than on the top. As you move up the food chain, the number of organisms decreases. A salt marsh shows this decrease in organisms. A large number of cordgrass plants feeds thousands of insects. These insects feed a few hundred sparrows. Finally, the sparrows feed only a few hawks. This lesson uses examples that show creatures eating only one type of organism. Point out that in real life most creatures eat more than one type of food.

Simple food chains, such as the one used in this lesson, are often shown as food pyramids. The base is made up of plants (e.g., cordgrass). The last level of carnivores (e.g., hawk) is at the top.

9. Draw on the chalkboard a food pyramid based on this food chain. The students can supply the names of organisms at each level in the pyramid. On page 4 of the Data Sheet, the students should fill in the numbers in the food pyramid. What would happen if the number of hawks in the marsh increased to 5? To 10? (See Data Sheet, page 4.) How is the marsh able to support all the plants and creatures that live there? (It is a very productive habitat.) What would happen to this food chain if the cordgrass were destroyed? (The food chain would collapse.)

What other marsh organisms feed on cordgrass? (Many feed on cordgrass detritus: worms, clams, crabs; these in turn feed other animals such as raccoons and clapper rails.) How is the productivity of the marsh linked to cordgrass? (Cordgrass is the basis of a salt marsh food web that includes many organisms.)

Examples

1. How many sparrows must the marsh have to feed one hawk for a week?

600 grams	÷	20 grams	=	30
Total weight of sparrows that one hawk eats		Weight of one sparrow		No. of sparrows needed to feed one hawk

2. How many grasshoppers must the marsh have to feed one sparrow for one week?

50 grams	÷	1 gram	=	50
Total weight of grasshoppers eaten by one sparrow		Weight of one grasshopper		No. of grasshoppers needed to feed one sparrow

3. How many plants must the marsh have to feed one grasshopper for one week?

15 grams	÷	5 grams	=	3
Total weight of cordgrass eaten by one grasshopper		Weight of one plant		No. of plants needed to feed one grasshopper

4. How many grasshoppers are needed to feed the number of sparrows eaten by one hawk in a week?

30	×	50	=	1,500
No. of sparrows needed to feed one hawk		No. of grasshoppers needed to feed each sparrow		No. of grasshoppers needed to feed all the sparrows eaten by one hawk

5. How many cordgrass plants are needed to feed all the grasshoppers that are eaten by all the sparrows that are eaten by one hawk in a week?

3	×	50	×	30
No. of plants eaten by one grasshopper		No. of grasshoppers eaten by one sparrow		No. of sparrows eaten by one hawk

= 4,500

No. of plants needed to feed all the grasshoppers eaten by all the sparrows that are eaten by one hawk

Quiz Answers

1. Because of the nutrient trap action, more nutrients and food are available to plants and animals in the estuary.

2. Wastes dumped or washed into rivers are also trapped and accumulated in estuaries and salt marshes, potentially harming organisms there.

3. False. Wastes dumped into rivers pollute downstream areas of the river and can accumulate in the estuary and salt marshes at the river's mouth.

4. Spiders. In the food chain in question, spiders are at the top of the chain. In general there are fewer organisms at the top of the food chain than on the bottom. Moving up the food chain, the numbers of organisms on each level decreases.

5. Cordgrass. These plants are on the bottom of the food chain. Organisms at the bottom of the food chain generally occur in the greatest numbers.

Name:

1 An estuary is a nutrient trap. Name one way in which this helps the plants and animals that live in the estuary.

2. State one way in which people can cause the nutrient trap to become harmful to the animals in the estuary.

3. It is all right for people to dump trash and other wastes into rivers because the flowing river water will wash them away. (Circle your answer.)

True **False**

4. Cordgrass, planthoppers, and spiders are part of a food chain in a salt marsh. Spiders eat planthoppers, and planthoppers eat cordgrass.

Write the name of the plant or animal from this food chain with the smallest number living in the marsh.

5. Which plant or animal in the food chain (Question 4.) has the biggest number living in the marsh. Write down its name.

Nutrient Trap Model

Cut around the outline and cut out the windows on this page. Then fold the page along the solid lines and tape down the flap to make a "sleeve."

Cut out **Slide A** on page 2 and insert it in the sleeve so that you can still see column 1. Pull it through the sleeve. Steps 1, 2, 3, and 4 show how the estuary builds up nutrients.

Repeat with **Slide B.** What happens when people dump pollution into rivers that feed estuaries?

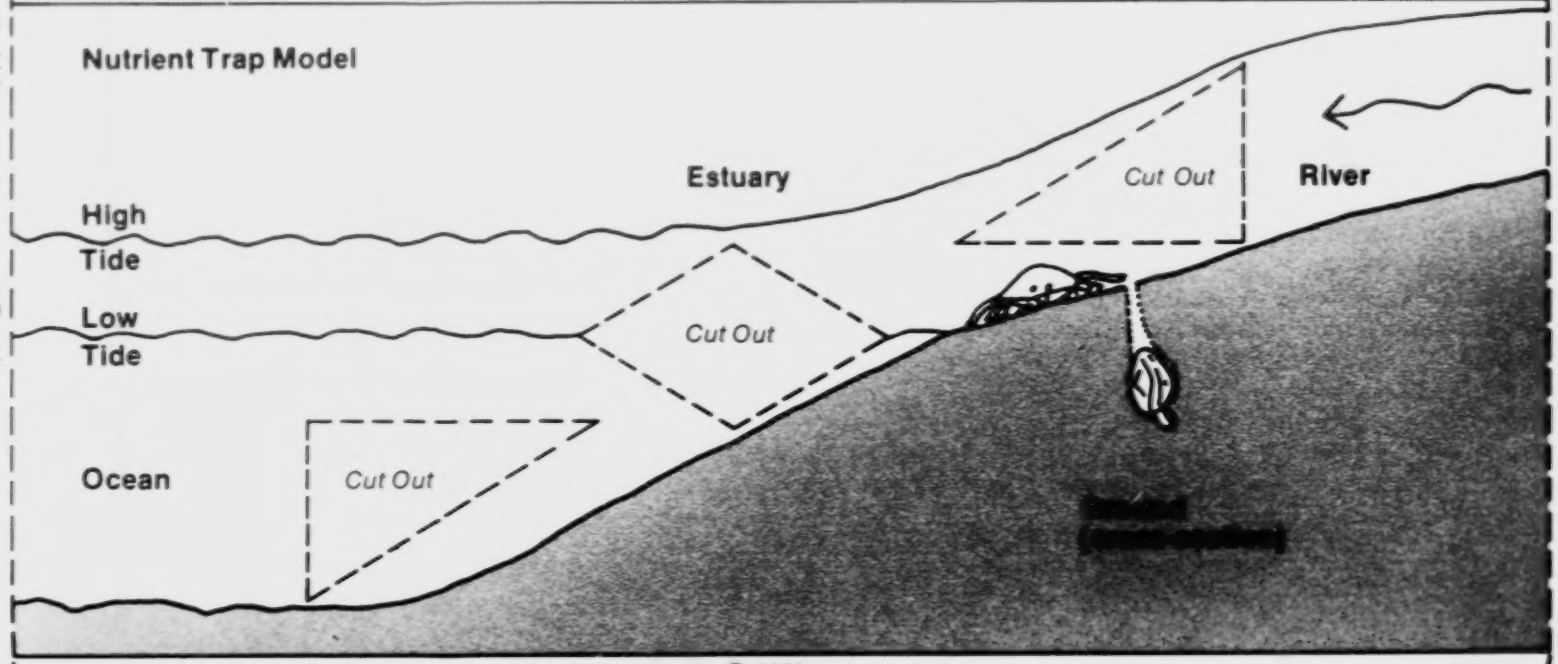
Back

Cut on Dotted Line

Front

Fold Here

Nutrient Trap Model



Fold Here

Name:

Name:

Data Sheet

Lesson Plan 3

Estuaries and Tidal Marshes

Nutrients & Pollutants

Nutrients

1. Freshwater carrying nutrients flows down-stream . . .

(pull to 2)

2. . . . through the estuary . . .

(pull to 3)

3. . . . to the sea. Nutrients mix with sea-water and when the tide comes up . . .

(push back to 4)

4. . . . they are carried back to the estuary.

Slide A

Nutrients

Nutrients

Nutrients

Cut on Dotted Lines

1. Pollution dumped in the river is also carried downstream . . .

(pull to 2)

2. . . . through the estuary . . .

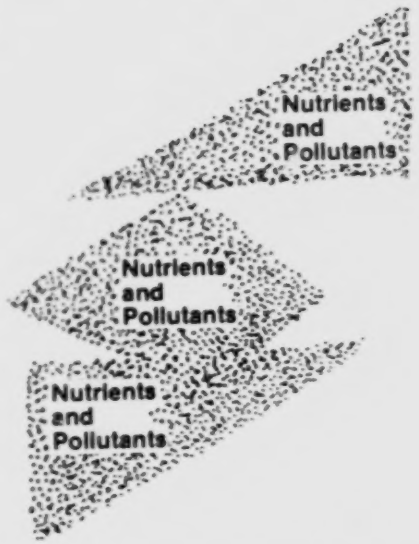
(pull to 3)

3. . . . to the sea. When the tide comes up . . .

(push back to 4)

4. . . . pollution is also carried back to the estuary.

Slide B



Name:

A wildlife biologist discovered these facts about a marsh food chain:

- A marsh hawk weighs 600 grams and eats 600 grams of seaside sparrows each week.
- Each sparrow weighs 20 grams and eats 50 grams of grasshoppers each week.
- Each grasshopper weighs 1 gram and eats 15 grams of cordgrass each week.
- Each cordgrass plant weighs 5 grams.

Use these facts to solve the following problems:

1. How many sparrows must the marsh have to feed one hawk for a week?

Hint:

Total weight of sparrows that one hawk eats	÷	Weight of one sparrow	=	Number of sparrows needed to feed one hawk

2. How many grasshoppers must the marsh have to feed one sparrow for a week?

3. How many cordgrass plants must the marsh have to feed one grasshopper for one week?

4. How many *grasshoppers* are needed to feed the number of *sparrows* eaten by one *hawk* in a week?

Hint:

Number of sparrows needed to feed one hawk	×	Number of grasshoppers needed to feed each sparrow	=	Number of grasshoppers needed to feed all the sparrows eaten by a hawk

5. How many cordgrass plants are needed to feed all the grasshoppers that are eaten by all the sparrows that are eaten by one hawk in a week?

Name:

1. At each level of the Food Pyramid write the name of the correct plant or animal and the number of each where there is a space.

Number ____
Name _____

Number ____
Name _____

Number ____
Name _____

Number ____
Name _____

2. Draw another Food Pyramid with five marsh hawks at the top. What would happen to the other animal numbers?

Name:

Can you Find Us?

Some of the creatures that live in the estuary are hard to see. They hide among cordgrass and under pilings or dig into the mud.

In this drawing the artist has hidden six salt marsh creatures — a mammal, a bird, a snail, a reptile, an insect, and a fish. Can you find them? Look for answers on page 2.

Name:

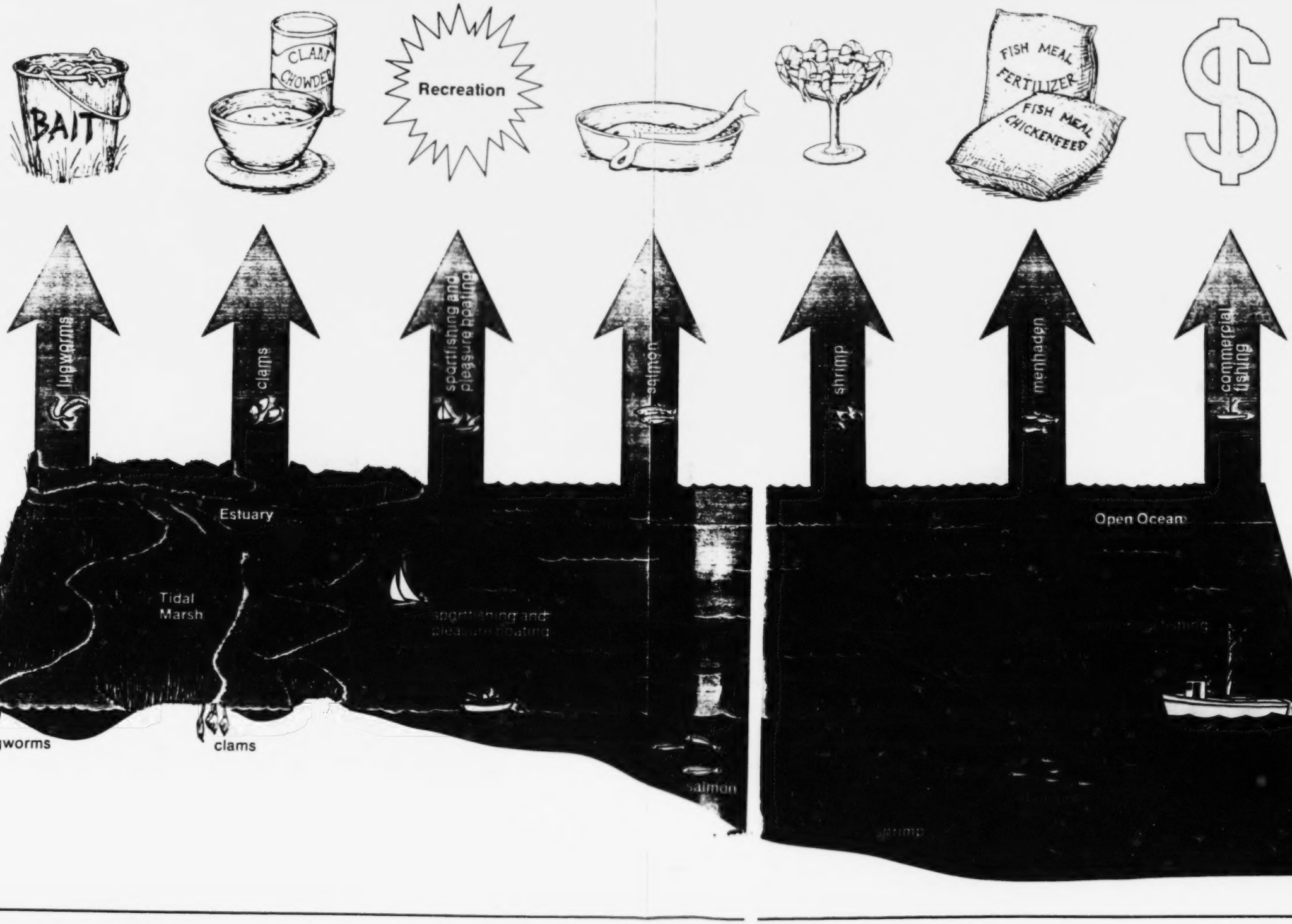
Marsh Tide

I watch the tide fill,
soaking reeds,
Feeding creatures buried
in sand.
I hear gulls scream, and a
buoy's *ding, dong*
calling ships.
A foghorn answers . . .

The ocean spreads, licking
my feet.
The smell of sea
rides the air.
I can taste salt on my lips —
The wind whips
the cordgrass
and tugs my hair.

C. Palmer

Answers to Hidden Animal Puzzle: Whitetail deer (mammal), clapper rail (bird), diamondback terrapin (reptile), marsh periwinkle (snail), longhorned grasshopper (insect), killifish (fish).



Benefits

Estuaries and Tidal Marshes

BEST COPY AVAILABLE

Developed by the U.S. FISH AND WILDLIFE SERVICE/DEPARTMENT OF INTERIOR
Produced by the NATIONAL INSTITUTE FOR URBAN WILDLIFE under a grant from EXXON COMPANY, U.S.A.

Printed at the expense of the Federal Government

The Estuary and Tidal Marsh

A Rich Variety

U.S. Fish and Wildlife Service Regions

Regional Offices

1 Lloyd 500 Building
500 N.E. Multnomah Street
Suite 1692
Portland, OR 97232

2 500 Gold Avenue, S.W.
P.O. Box 1306
Albuquerque, NM 87103

3 Federal Building
Ft. Snelling
Twin Cities, MN 55111

4 Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, GA 30303

5 One Gateway Center
Suite 700
Newton Corner, MA 02158

6 P.O. Box 25486
Denver Federal Center
Denver, CO 80225

7 1011 E. Tudor Road
Anchorage, AK 99503

Department of the Interior
U.S. Fish and Wildlife Service

National Institute for Urban Wildlife

10921 Trotting Ridge Way Columbia, Maryland 21044

The mission of the National Institute for Urban Wildlife is to be a responsible and effective scientific and educational organization advocating the enhancement of urban wildlife values and habitat and the wise use of all natural resources for the benefit of people in cities, suburbs, and developing areas.

The Institute is the only private national conservation organization with programs dealing almost exclusively with fish and wildlife in urban and other disturbed areas. Funded through private and corporate contributions, grants and contracts, it is filling some of the glaring gaps in information and methodologies needed for the management and enjoyment of wildlife and wildlife habitats in urban areas.

The Institute accomplishes its mission by (1) conducting sound research on the relationship between man and wildlife under urban and urbanizing conditions; (2) discovering and disseminating practical procedures for maintaining, enhancing or controlling certain wildlife species in urban areas, and (3) by building an appreciation for, and understanding of, wildlife and a positive conservation ethic at the local community and neighborhood level, and illustrating how all segments of our people have a vested interest in wildlife and the environment we mutually share.

Developed by the U.S. FISH AND WILDLIFE SERVICE/DEPARTMENT OF INTERIOR
Produced by the NATIONAL INSTITUTE FOR URBAN WILDLIFE under a grant from EXXON COMPANY, U.S.A.

Printed at no expense to the Federal Government.